Progress Report

The role of attention in visual processing

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In the last progress report, I noted that I had recently demonstrated attentional modulation of two new aftereffects. The results at that time were tentative and required replication. During the last six months, I have solidified these results, and will discuss each in turn.

The first aftereffect concerned adaptation of the Schroder staircase, which is a reversible perspective figure like the Necker cube. If one adapts to an unambiguous version of the staircase, biased towards one perspective, the ambiguous figure appears in the opposite perspective. During the adaptation phase, I superimposed two unambiguous adapting staircases in opposing perspective. Both staircases were centered on fixation and were of different sizes and colors to increase their discriminability. During the adaptation phase, color changes were occassionally introduced in the transverse line segments that defined the steps of each staircase. These color changes were brief (100 ms) and occurred randomly about the fixation point. In different blocks of trials, subjects detected the color changes in one or the other staircase. Following the adaptation phase, subjects judged the perceived persepective of the ambiguous test staircase. The basic result is that the test staircase is seen in the perspective opposite the task relevant staircase.

This result has now been replicated. Furthermore, I have demonstrated a similar pattern of results in another reversible perspective figure, the Necker cube. The basic 'opponent' method of these experiments is the same as that used to demonstrate attentional modulation of the three dimensional motion aftereffect. The model developed for the latter aftereffect has also been used to analyze the data from the current experiments. The attention coefficient 'k' from the model, which quantifies the degree of attentional modulation of the aftereffect, was larger (meaning less modulation) for the reversible perspective figure aftereffect than the three dimensional aftereffect. This difference probably relates to the spatial configuration of the opposing adapting stimuli in each experiment. The opposing staircases spatially overlapped whereas the opposing rotating squares occupied distinct spatial locations. The overlapping configuration probably led to less efficient selection of the task relevant staircase, resulting in a larger attention coefficient. The results of these experiments and the application of the model to the data have been written up and

submitted for publication.

During this grant period I have also examined attentional modulation of the tilt aftereffect (TAE) produced by bars defined by motion discontinuities. These experiments involved a distractor design in which during the adaptation phase, subjects either attended to the adapting bar or an irrelevant stimulus. As noted in the previous report, I have developed a powerful secondary task in which subjects must judge color conjunctions in a set of colored disk-annulus combinations which are arranged in a square or triangular configuration centered on fixation. During the adaptation phase subjects either detect color changes in a string of dots at the left or right edges of the bar, or detect color conjunctions. I have found that the perceived tilt of the test bar is greater when subjects attend to the adapting bar rather than the color conjunctions.

During the last grant period, several additional experiments were conducted. I have replicated the basic result, with a somewhat improved stimulus display and minor design changes. I also tried to see if the same finding could be demonstrated using an opponent design in which two adapting bars of opposite tilt are presented. Unfortunately, I was not able to design an adequate display. The basic problem is twofold 1) the TAE is highly retinotopic, restricting the possible spatial separation between the adapting and test bars 2) the adapting bars cannot be distinguished by color or some other parameter since the bars can only be defined by motion. The net effect is that it is difficult to design a display in which each bar can be separately attended. Although it would be preferable to demonstrate attentional modulation of the TAE with an opponent design, the basic result using the distractor design appears quite robust.

I am now conducting experiments to determine if attentional modulation can also be demonstrated with TAEs in which the bars are defined by luminance and texture differences

During this grant period, I have also examined the possibility that eye movements might explain the effect of attention on the three dimensional motion aftereffect. One suggestion is that during the adaptation phase, subjects pursue the front side of the task relevant staircase. Large eye movements seem very unlikely since subjects' only task is to detect perturbations in the rotating stimulus that are centered on fixation. It is also unclear how any pursuit movement would bias the subsequent response to the test figure. However, I have been conducting experiments to examine this issue more closely. One approach is to measure eye movements during the experiment. So far, the basic result is replicating. Subjects do not generally pursue the dots, However, when they do, they do not make the type of eye movements noted above. Rather they seem to follow a single dot for a complete rotation. This produces eye movements both left and right and should not bias the aftereffect one way or the other.

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